2006 Public Health Information Network Conference

# The California Public Health Information Network:
# Architecture and Implementation of a Public Health Edge Server within Hospital and Public Health Laboratories
# A Case Study

http://calip.ucdavis.edu

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## Environment

Comment:

Policy, governance and security issues are inherently much more difficult to overcome in hospital vs. public health laboratories.

However, several hospitals, some large groups, clearly realize the importance of seeking standards based interoperability solutions, not just for reporting, but for other initiatives (e.g. RHIO's) as well.

## California

Population: > 36 million (2005)

61 local health jurisdictions ranging from 1,100 people (Alpine County) to over 10,000,000 (Los Angeles)

## Hospitals

~ 520 Hospitals

Target in initial phase:
First Receivers including trauma (adult and pediatric) centers or approximately 120 hospital laboratories

Three largest hospital groups comprised of ~ 40 (Catholic Healthcare West), 23 (Sutter Health) and 14 (Kaiser Northern California) labs with variable harmonization of laboratory infrastructure

## Public Health Laboratories

39 Public Health Laboratories

Several leading LIMS vendors

One laboratory has no LIMS. Funding/procurement status prevents purchase of a LIMS, but allows the lab to build their own system. Another is uncertain about exposing data outside their local domain.

Most eager to receive support, training and hardware to realize interoperability with public health systems.

Business Documents

# Defining the Relationship

- Reciprocal Confidentiality or Non-Disclosure Agreement
- Memorandum of Understanding (not a Business Associate Agreement)
- Service Level Agreement
- Public health agency policy and governance must be explicit, comprehensive and well crafted.
- Despite public health domain, hospitals remain very concerned about sharing data considered intellectual property (e.g. laboratory catalogs or knowledge of business practices).

**CalPHIN Laboratory Integration**

# Building the Team

- System engineers/administrators
  - Few do both Windows and Linux equally well.
- "Public Health Information Specialists"
  - Working directly with laboratory and laboratory information systems staff to gather and process test codes for translation to LOINC and SNOMED
  - Recruiting laboratorians (CLS, MT) was difficult. Final team comprised of physicians, veterinarians, and biomedical informaticists.
    - As learning curve began to stabilize, collaboration within and outside the group increased. Several found their "niche" (e.g. NLP, database design/ schema, terminology development, etc.)

## Workflow for laboratory test translation

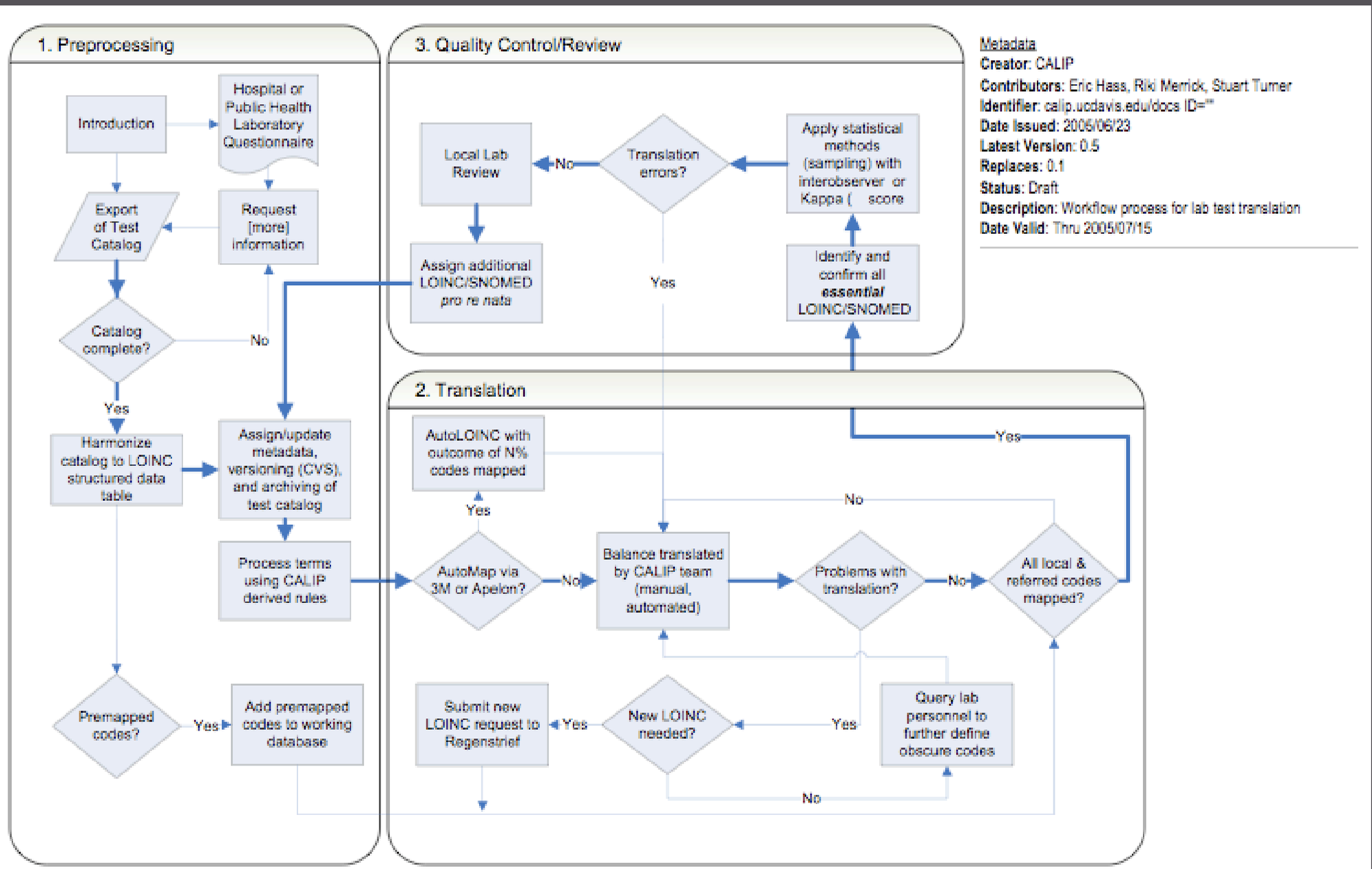
Normalization to a standard database structure (SAS) including LOINC classes

Natural Language Processing (stemming, tokenization, regular expressions, building queries)

Iterative data gathering and pre-processing from multiple sources (e.g. draw station DB for specimen type)

Terminology service partners (e.g. 3M Health Information Systems)

Lab catalogs varied from several hundred to around 15,000 test codes. Identifying which are “of interest” is challenging!



# Server hardware and application stack Objectives

**Requirements**

Application Stack

Operating System: **Linux** or Windows Server (~ 80:20)

Database: PostgreSQL

HL7 Integration Engine, Mapping and Customization: Orion Rhapsody and Orion Symphonia

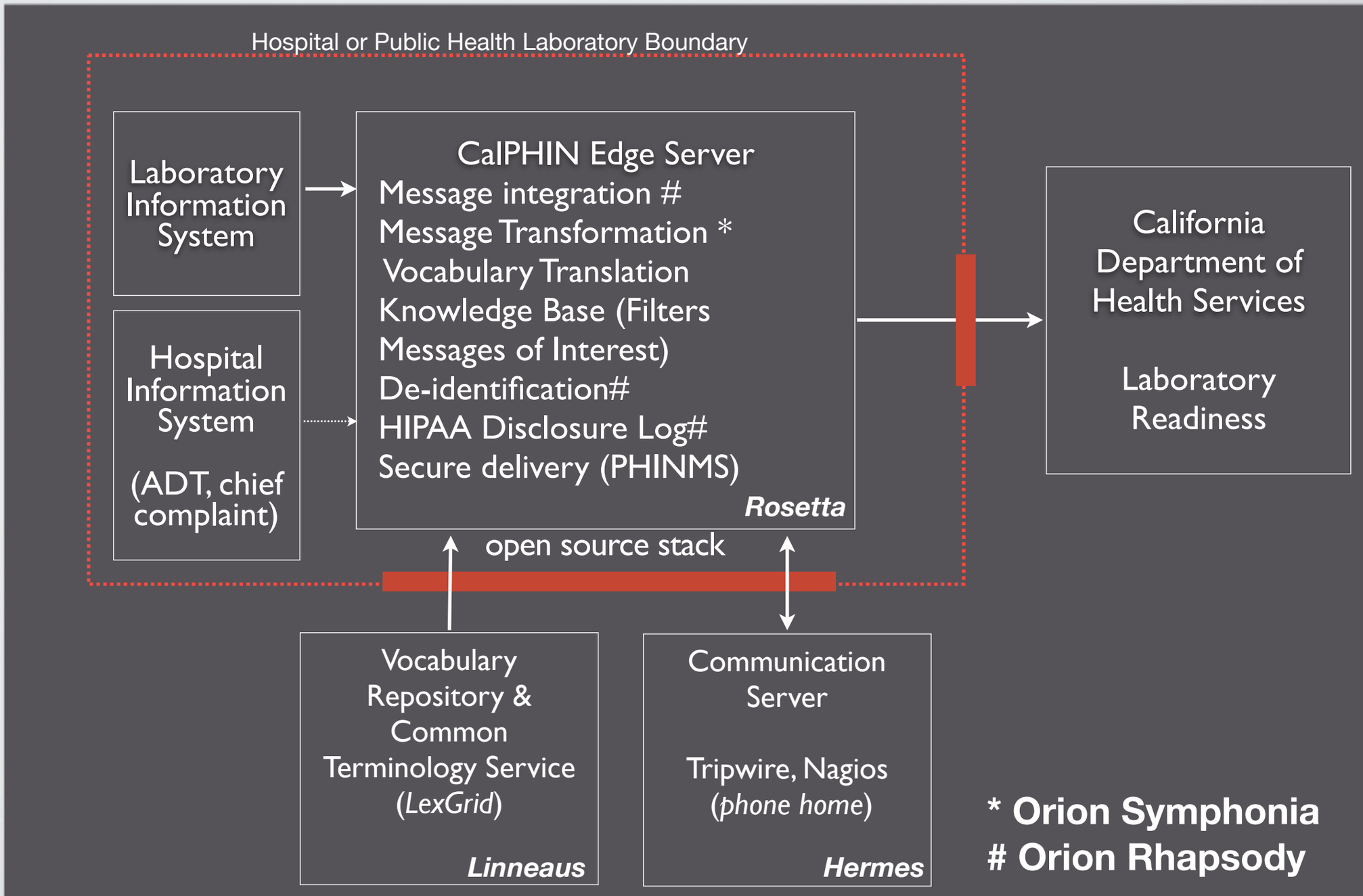
System Hardening: Bastille Linux

Antivirus: ClamAV

Security: Many (Nagios, Snort, Tripwire)

- Should be platform agnostic. Default application stack is **Linux** (Red Hat ES), Java Virtual Machine (JVM), **PostgreSQL** (database) and several open source security tools (e.g. Nagios). The knowledge base in the **Protege** Ontology Editor is not run as a service. The frame based knowledge is converted to a relational database
- Integration vendor, Orion Health, using **Orion Symphonia Mapper** and **Orion Rhapsody**, uses the Apache Tomcat web servlet container.
- Ease of remote management in a headless environment
- Design/architecture leverages as much enterprise-ready open source components and libraries as possible
- Strongly supported hardware (e.g. HP Proliant, Dell PowerEdge) with minimum lifecycle of 60 months.

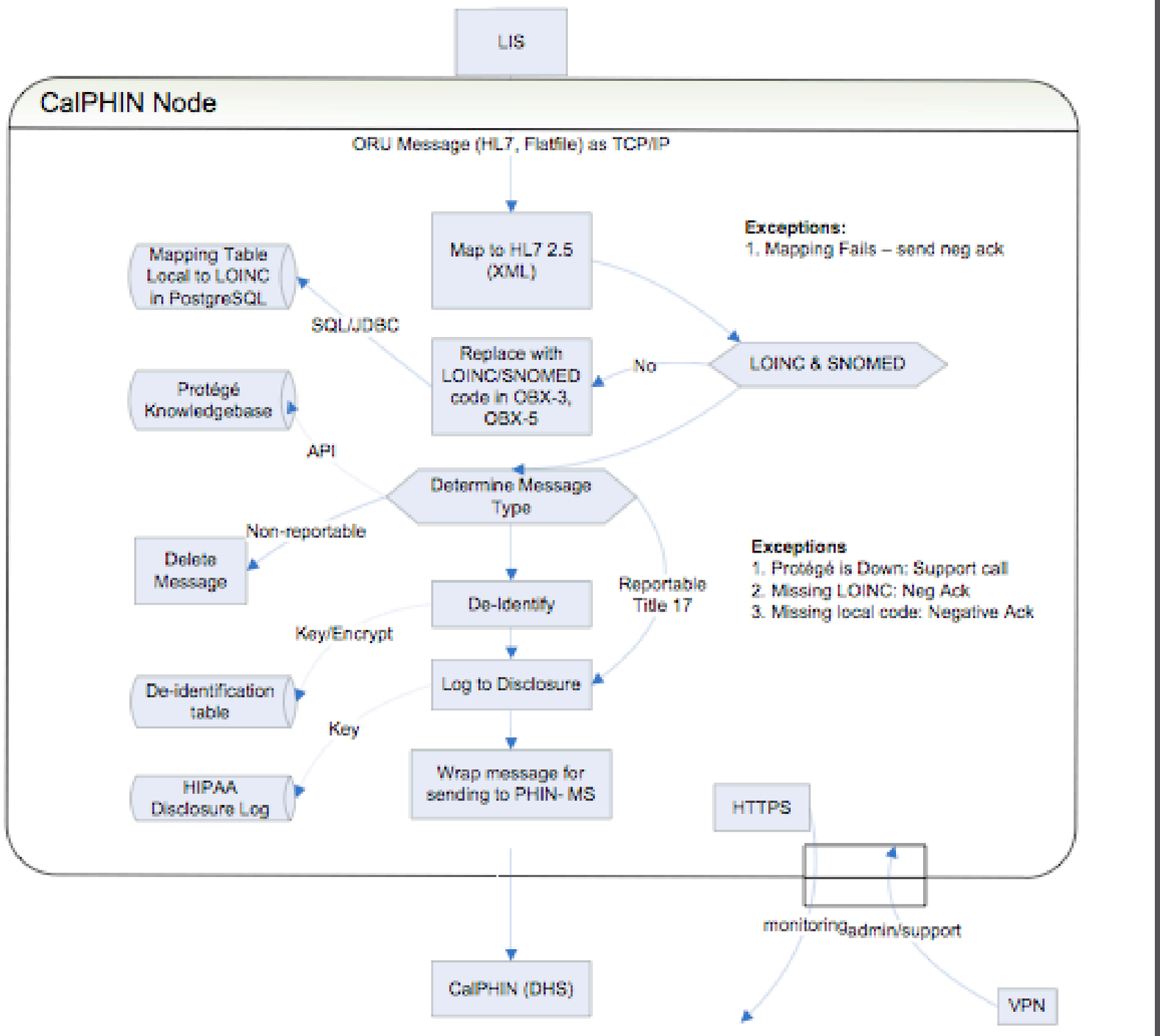
# Architecture: High Level




*** Orion Symphonia**
**# Orion Rhapsody**

## Edge Server Workflow

Edge Server Workflow



# Unified Modeling Language

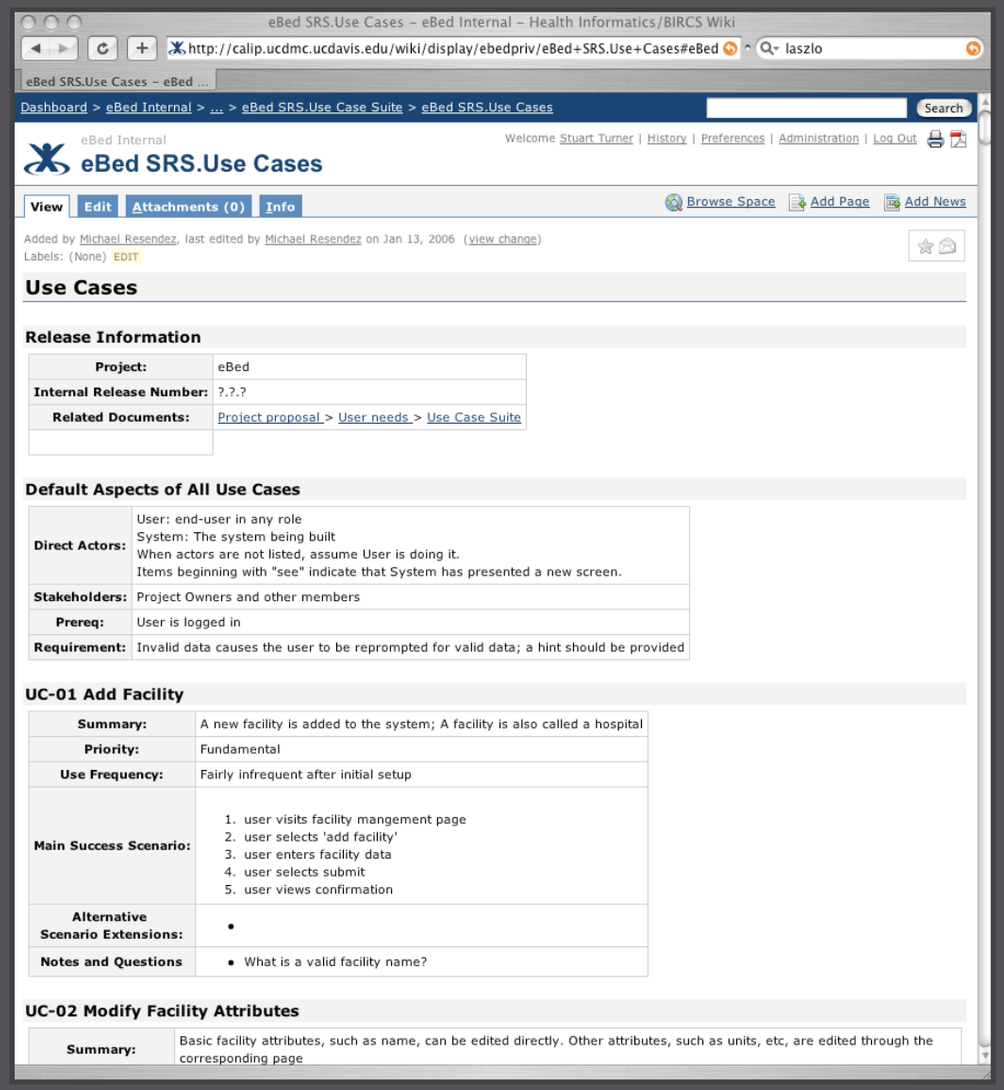
Collaborative planning through UML is essential.

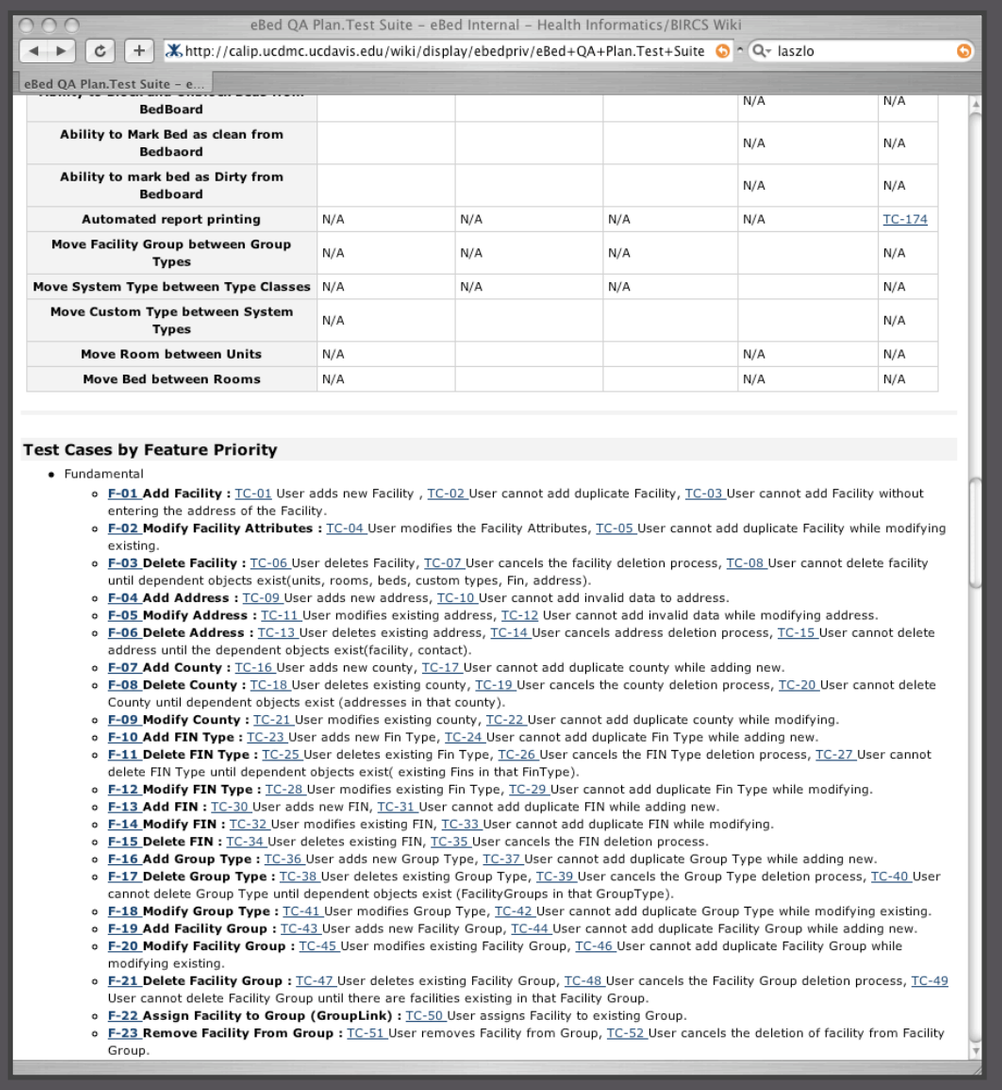
Use Case Diagrams and Documents

Class Diagrams (Object and Logical Modeling)

Activity Diagrams

Deployment Diagrams

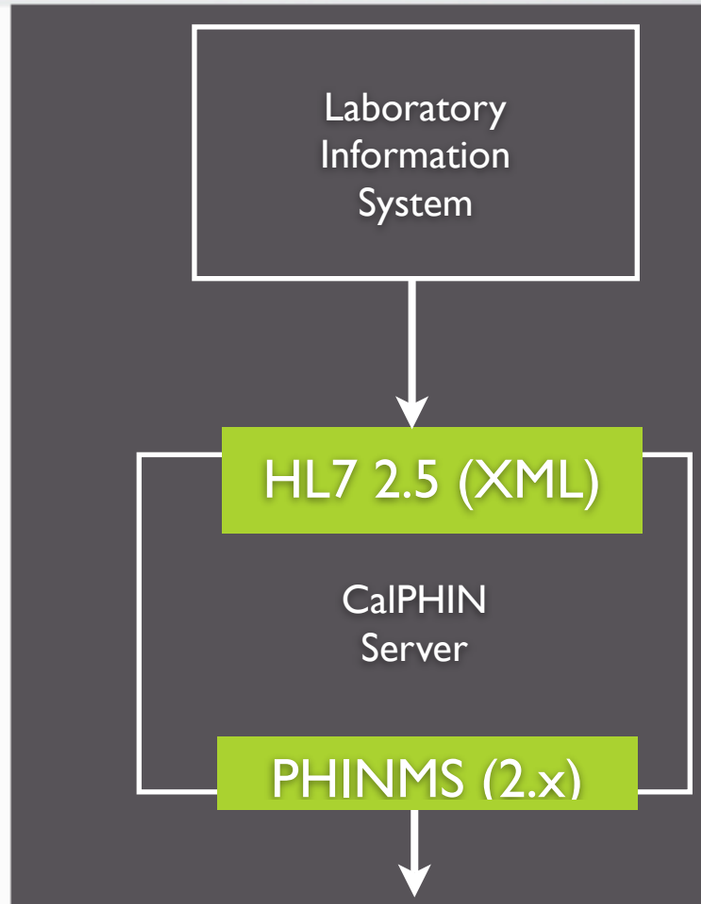


**Requirements**

# Syntactic Interoperability

- Message transformation
  - Most labs were able to send an HL7 message. Versions and implementations were widely variable. Documentation was often of little value. A set of sample (but representative) messages was best method to perform mapping.
  - All messages mapped immediately to HL7 2.5 (Orion Symphonia) in XML, despite what target application required, before messages were processed further.
  - Message transformation relatively trivial. Properly populating the message from the laboratory information system was not (next)



**Requirements**

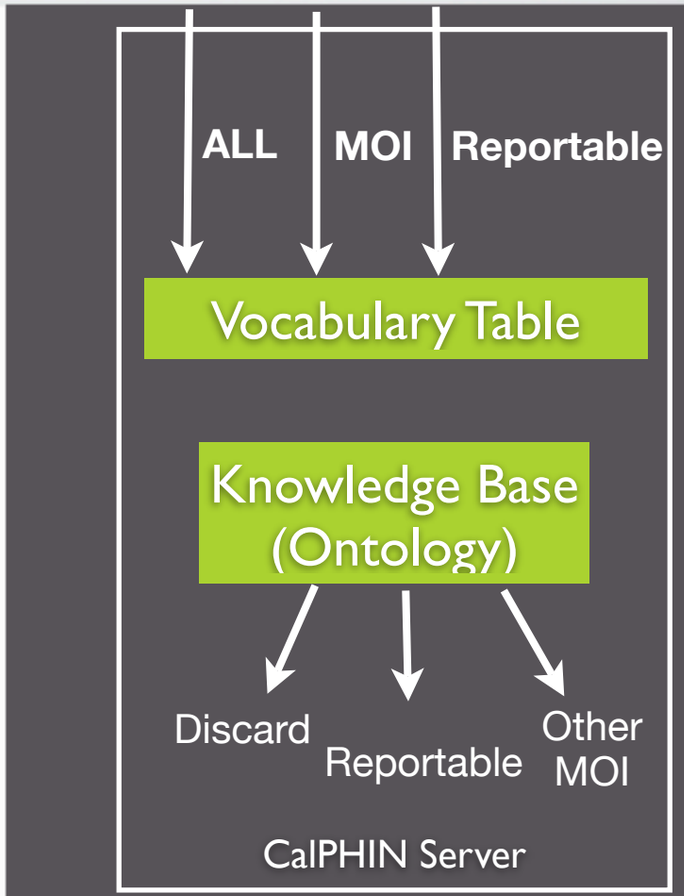
# Semantic Interoperability: Messages of Interest

MOI: Messages of Interest

Any message intended for public health reporting either as a legally mandated reportable messages, an additional message for ad hoc reporting or surveillance, or a message intended for other use cases (e.g. RHIO, bed capacity, etc.)

This is distinguished from “reportable” messages which more clearly refer to those falling under legislation - or Title 17 Section 2505 in California

- Knowledge base, developed as an ontology (Dr. Cecil Lynch) created to filter messages of interest.
- Receiving properly mapped (LOINC/SNOMED) messages was one of the most difficult challenges. Many LIS were unable to populate these additional data elements without redevelopment as a separate object class/attribute pair or a entity/relation in their native databases. Therefore, mapping (vocabulary) tables maintained in the server
- LIS ability to filter for Messages of Interest (MOI) or legally reportable messages was unreliable. The knowledge base allowed for message interrogation (OBX-3, LOINC) and subsequent parsing.

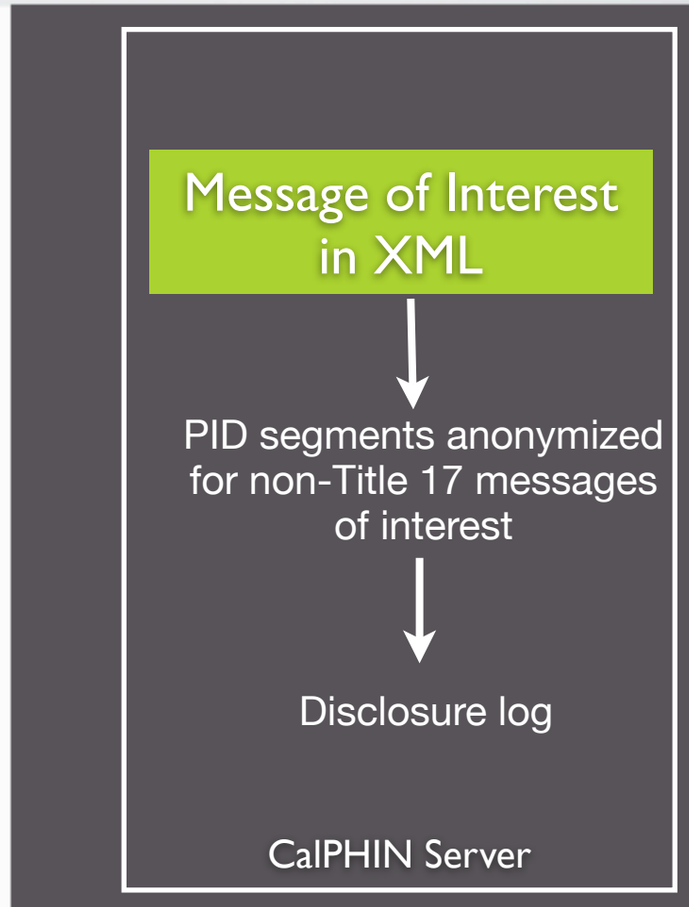


# De-identification
# HIPAA Disclosure log

Disclosure log:

We discovered that most systems had no method of processing an electronic disclosure log. In general, IT staff had to refer to a HIPAA compliance officer (or other) for advice on methods of archival (e.g. frequency, duration, location, etc.)

- Although the core implementation required submitting reportable messages currently required by law in California under Title 17 that intrinsically should not be anonymized, the intent of the architecture was to be extensible for all public health message use cases. This is especially true for hospitals (e.g. ADT, chief complaint, bed capacity, patient record summaries, etc.)
- De-identification on an HL7 message was relatively trivial (PID segment).
- LIS ability to filter for Messages of Interest (MOI) or legally reportable messages was unreliable. The knowledge base allowed for message interrogation (OBX-3, LOINC) and subsequent parsing.



**Semantic Interoperability**

## Requirements Gathering

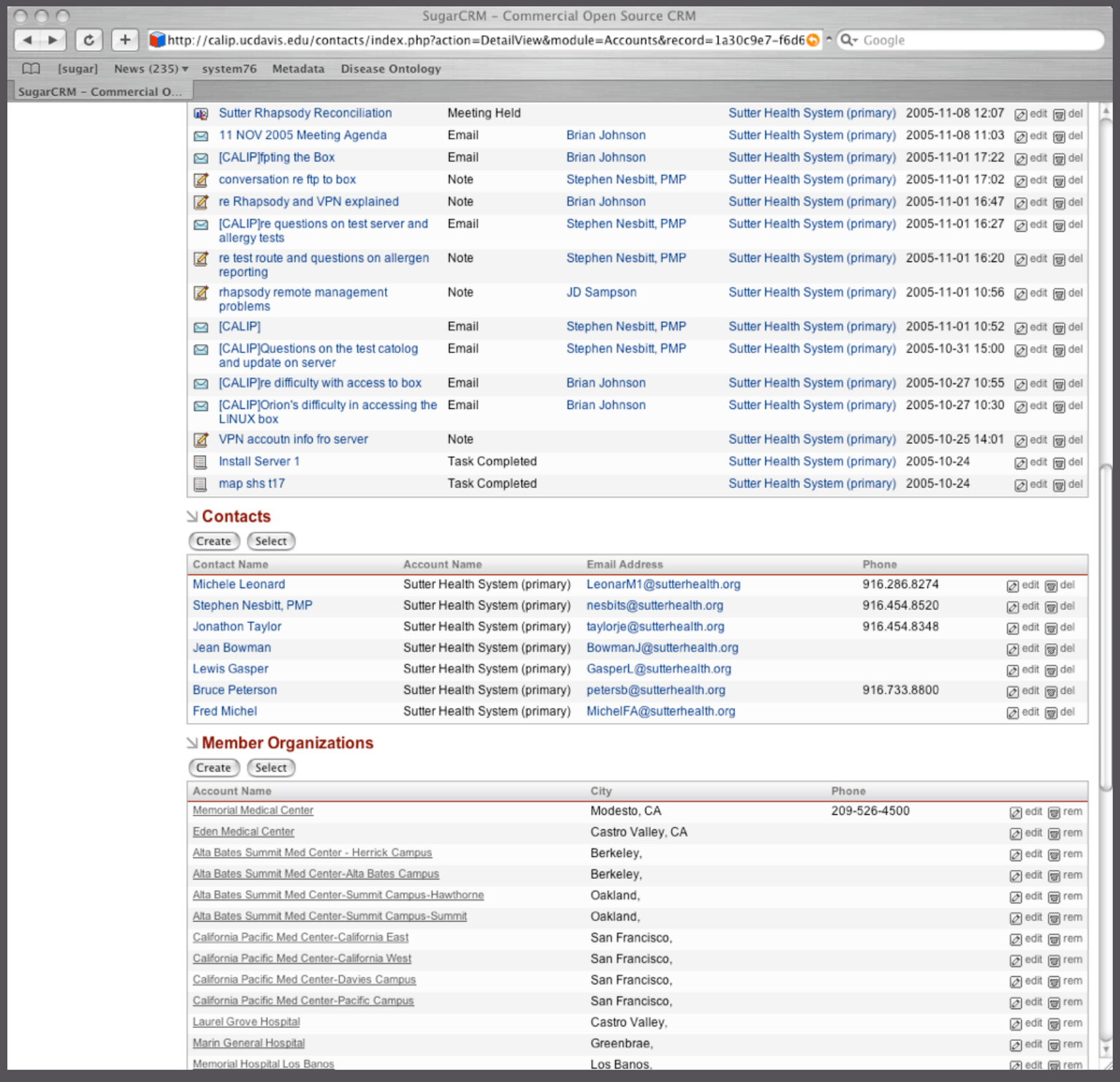
# Server

- IT network topology and security analysis.
- Obtain VPN access agreements and tokens.
- Procure, build, test, ship, rack, network, configure CalPHIN application server.
- Obtain message specifications (HL7, flat file) and sample messages.
- Complete integration of vocabulary tables (LOINC/SNOMED) into application server
- Build transformation scripts (Orion Symphonia).
- Orion Rhapsody team builds configuration scripts or “communication points” based on local requirements. Local (UC Davis) Rhapsody engineer works with Orion to further customize scripts and manage the routes.
- Test the route (unit, regression, communication testing, data validation with phantom target).
- Security analysis
- CALIP assesses PHIN certification steps.

## Collaboration

Web-based, mostly open source communication tools

Enterprise Customer Relation Management Application (SugarCRM)

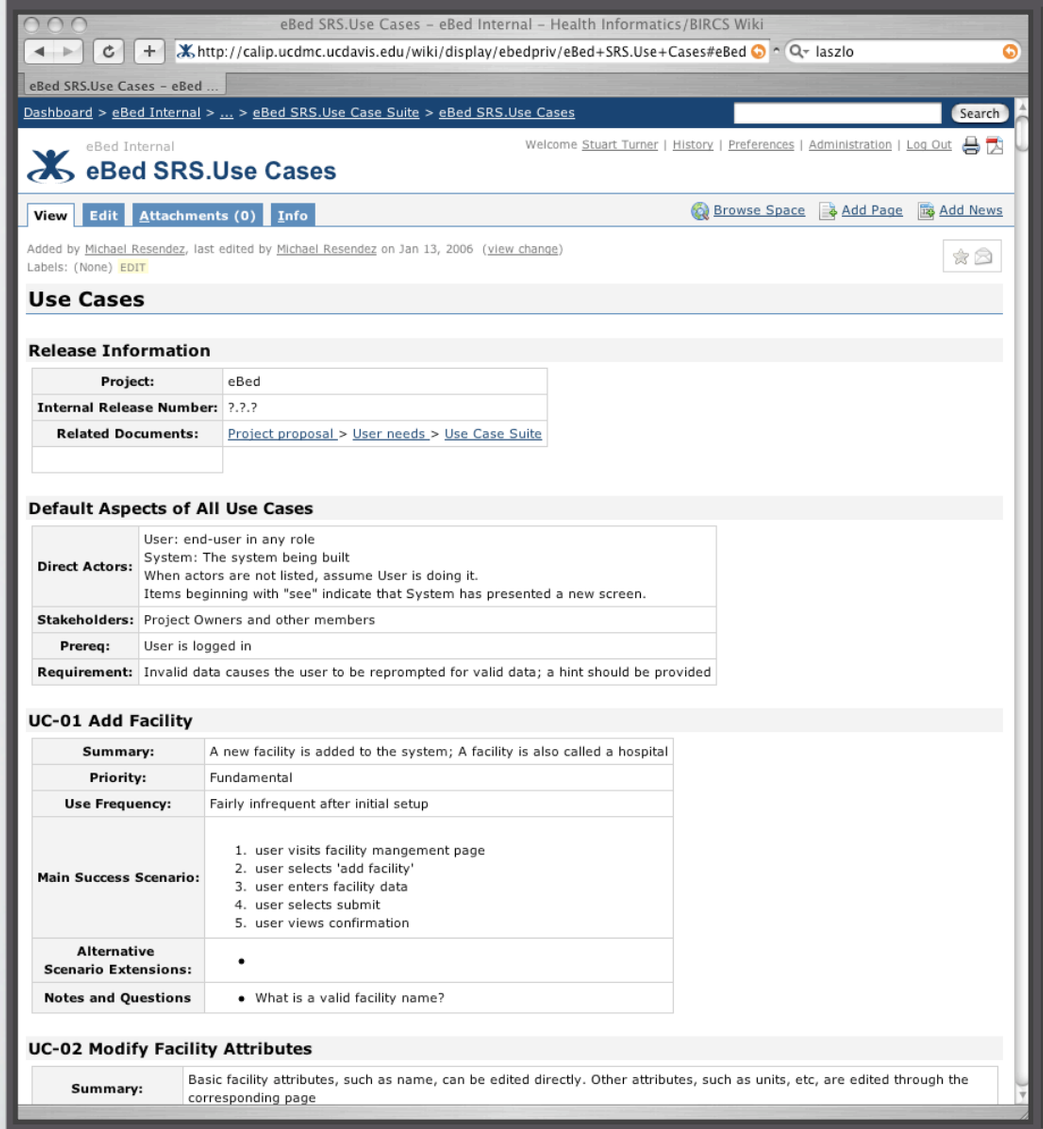


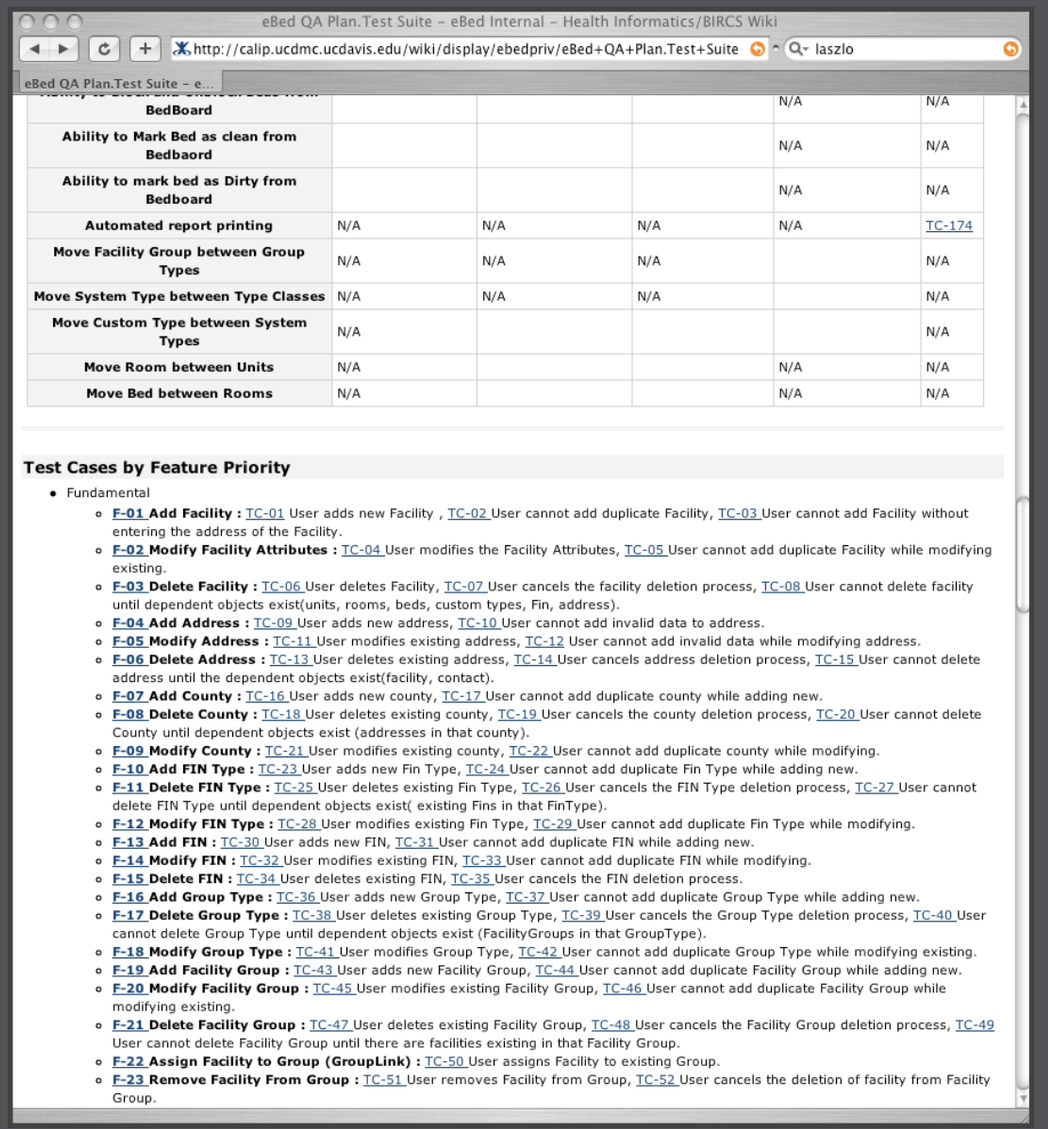
## Collaboration

Most successful communication tool has been the Wiki.

Project evolved from use of several open source Wiki's (e.g. Wikimedia) to an enterprise commercial offering (Atlassian Confluence).

This decision was mostly based on robust permissioning that was not available in open source versions as well as integration in to an issue tracking application (Atllasian JIRA)



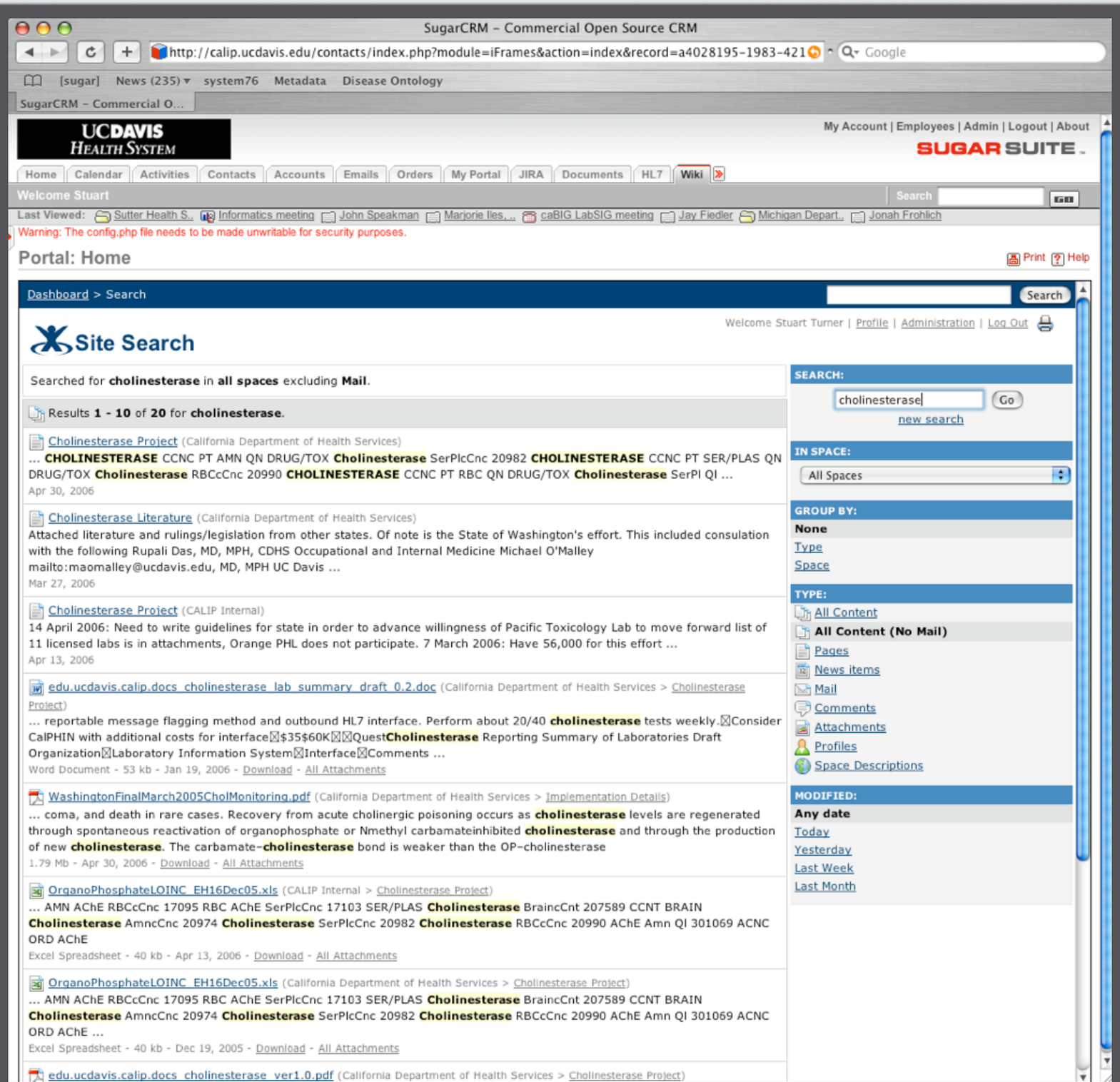



## Collaboration

Online tools allowed staff to update content from anywhere.

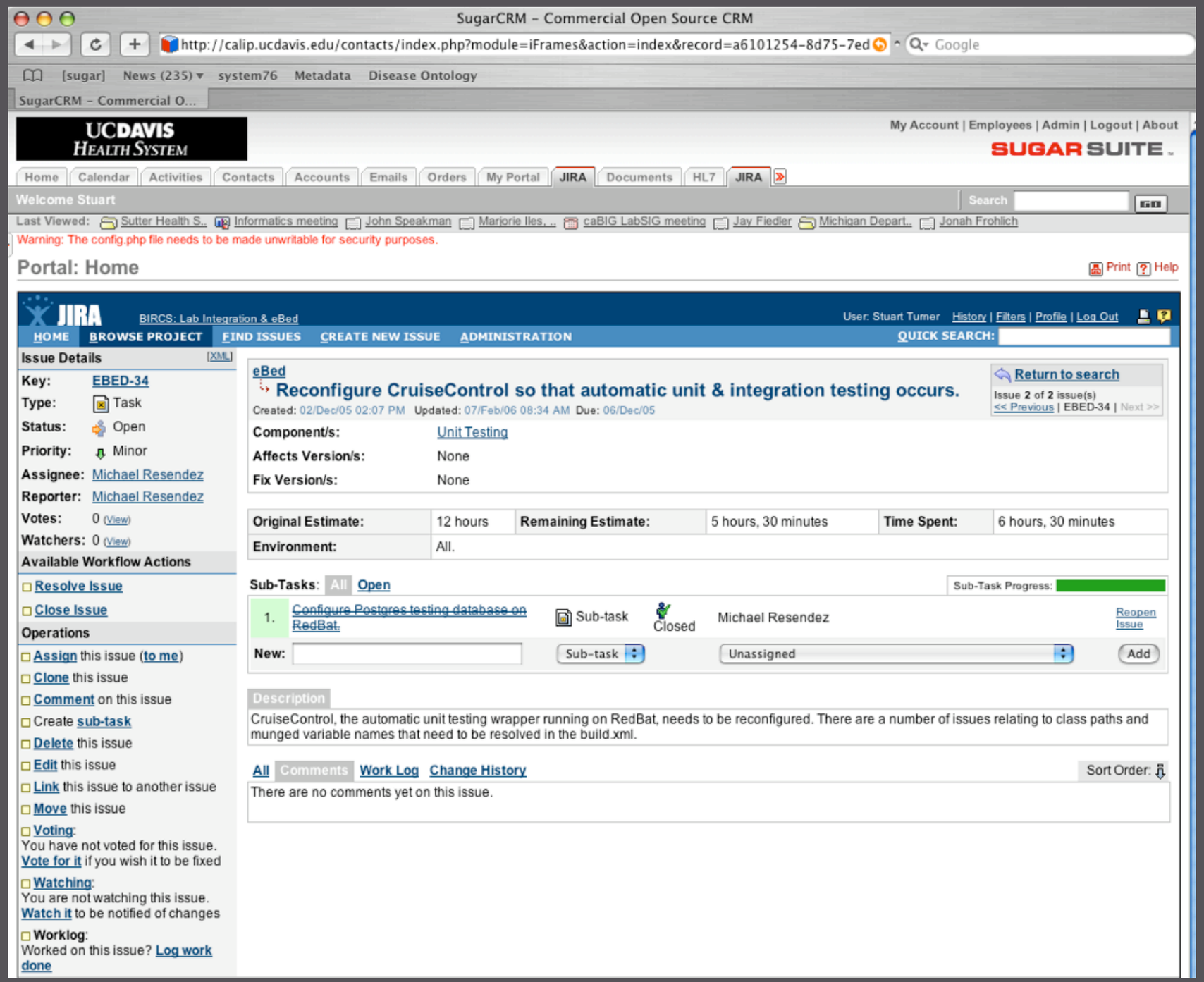
Fully searchable.

Documents, meeting agendas, internal memos, etc.



## Collaboration

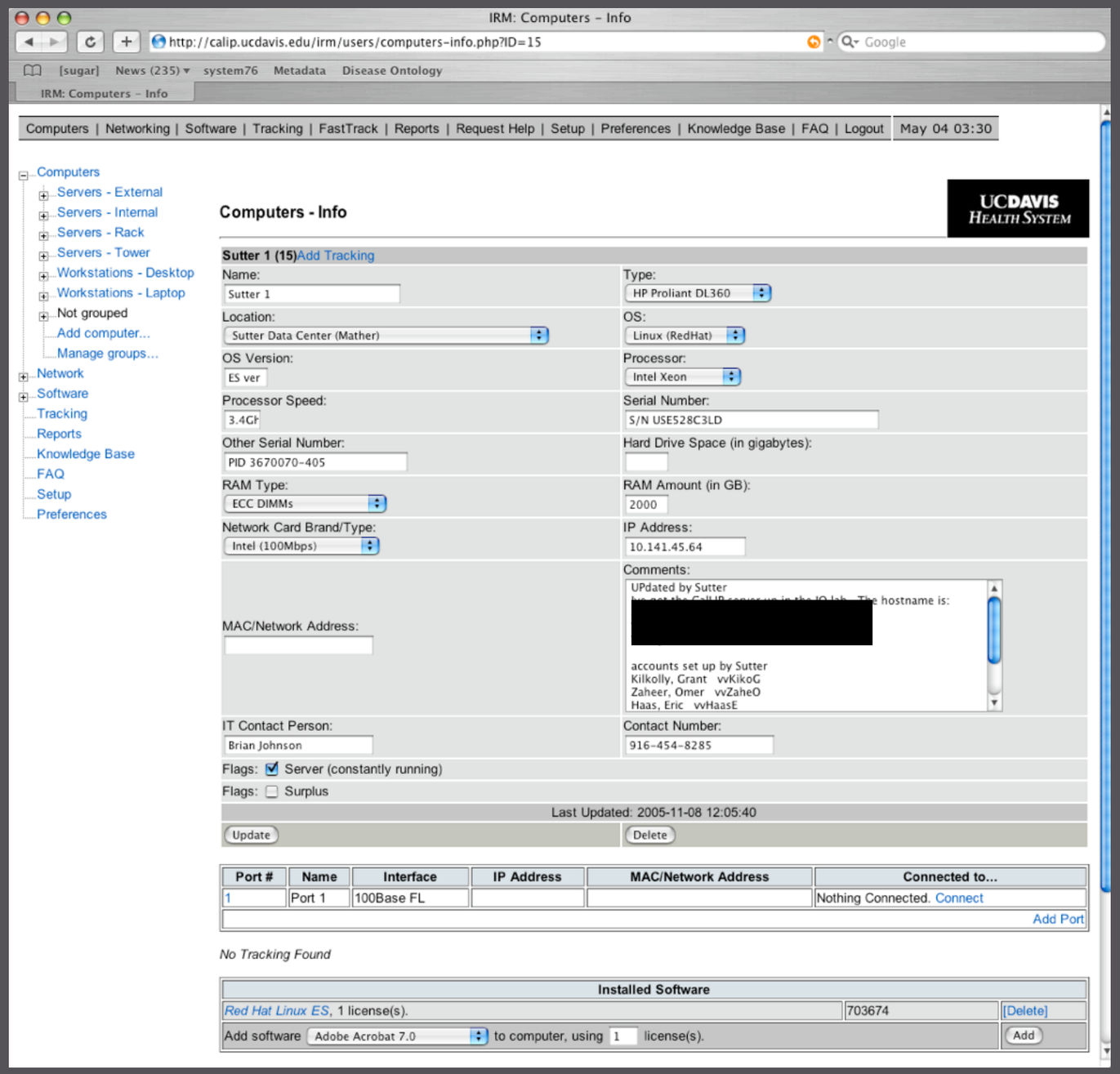
Project Management
Issue/Feature Tracking



## Collaboration

Asset Tracking

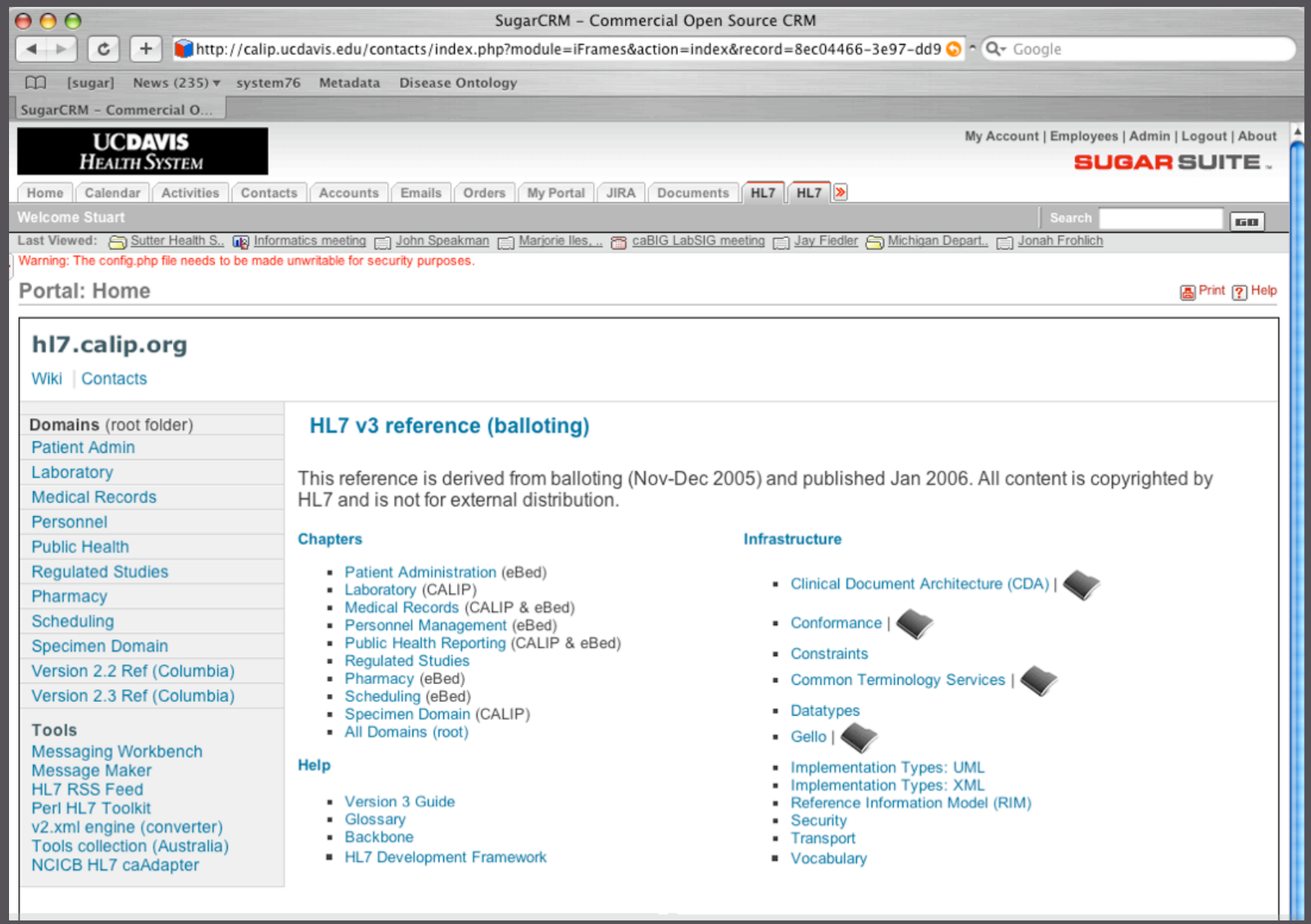
All server information including contacts, configuration files, software licenses, etc.



## Reference Information

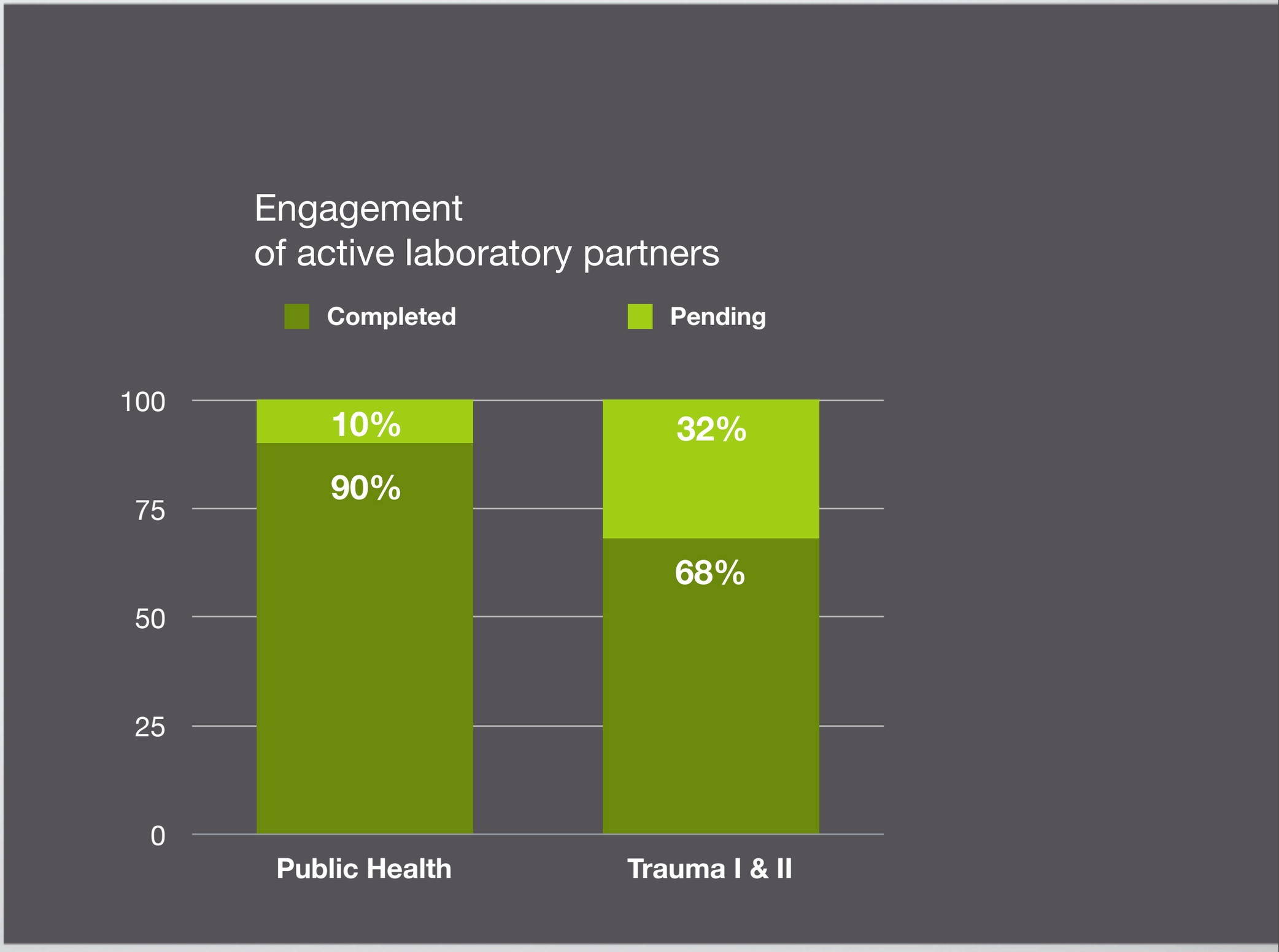
All important reference or standards documentation or other links to papers were kept within the same portal.

This includes links to files as well as a Document Management System that allowed inclusion of metadata (Dublin Core) to facilitate searching.



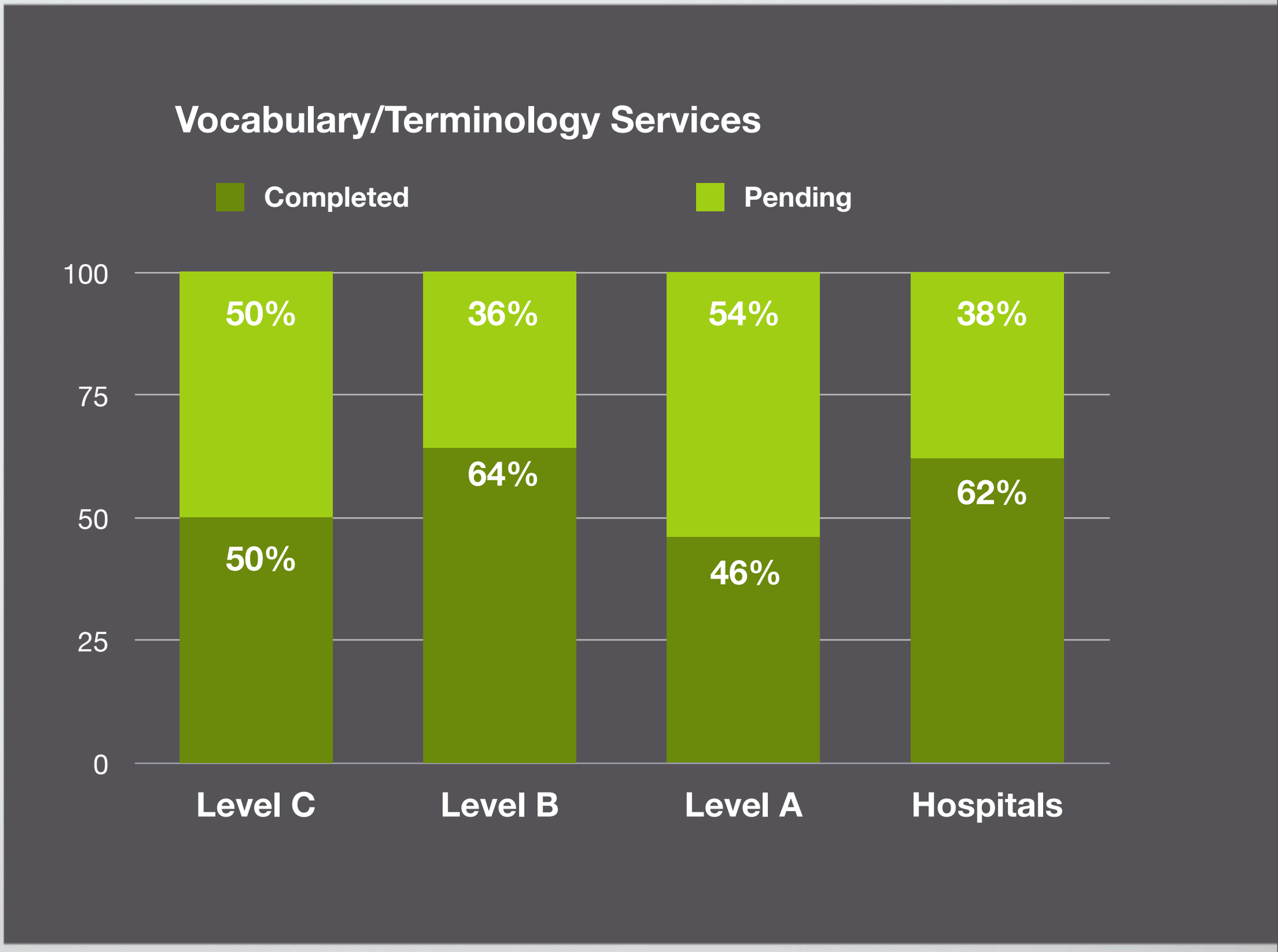
## California Laboratory Integration

## Year 1



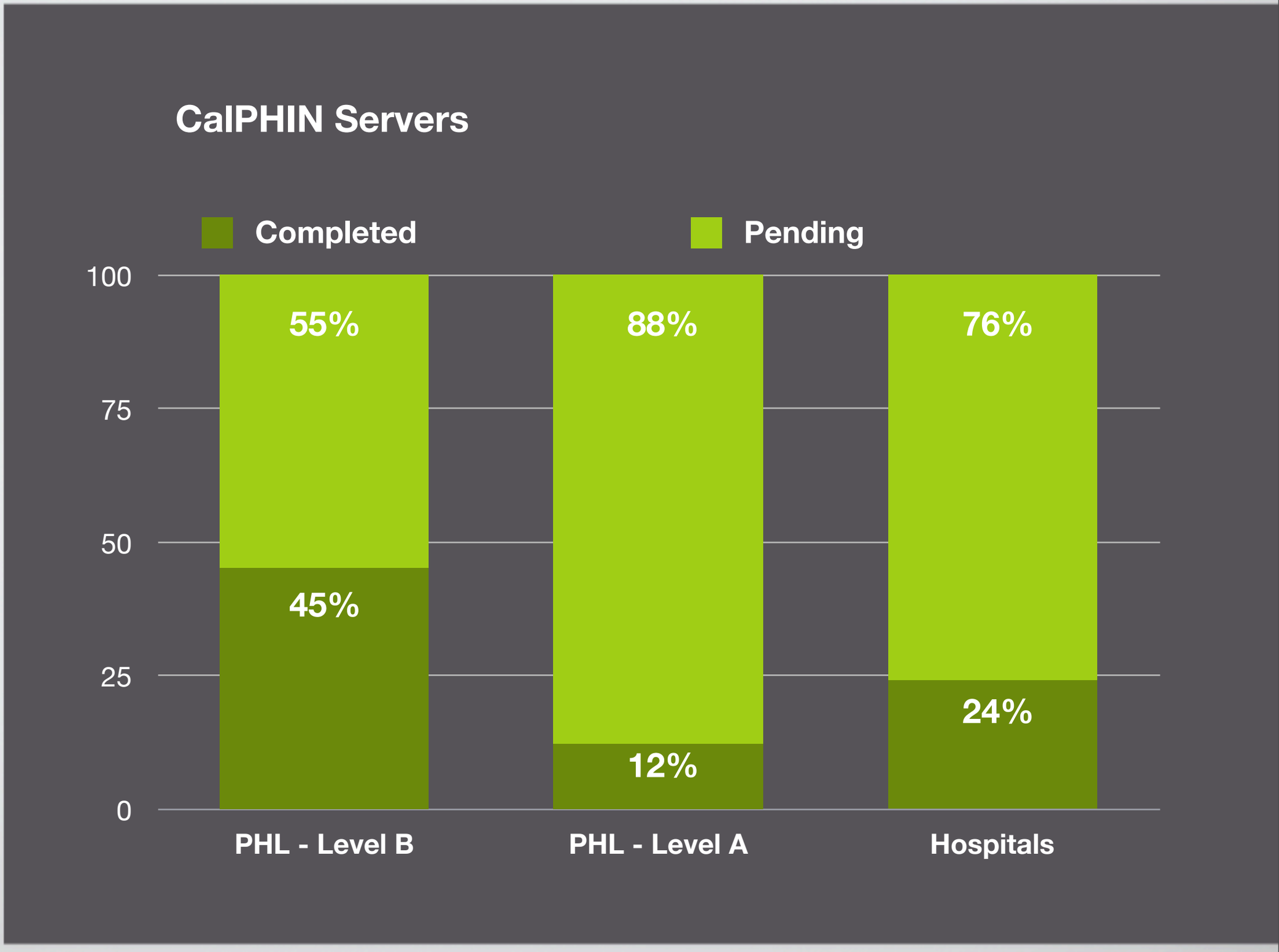
**California Laboratory Integration**

**Year 1**



# California Laboratory Integration

## Year 1

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# Objectivist and Subjectivist Evaluation Processes

- Objectivist
  - Comparison-based (implementations in other states). Similar process to random controlled studies in clinical research
  - Objectives-based: Has the implementation met expectations (Were there expectations?)
  - Decision-Facilitation (Formative process designed to answer questions important to developers ; evaluate alternatives)
- Subjectivist
  - Professional review
  - Responsive/Illuminative (interviews with all prototypical users including laboratorians, hospital administrators, public health personnel, patients)

Evaluation Methods

# Lessons learned

- Policy (governance) first
- Thorough planning including formal and shareable modeling processes (UML)
- Integration of end-users (hospital and public health laboratories) into a pervasive open collaboration environment
- Be firm and progressive regarding syntactic and semantic interoperability.
- Iterative review and evaluation. Be agile. Waterfall methodology dangerous given the timeframe

**Acknowledgement and thanks:**

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**CALIP Project Staff University of California, Davis**

# Questions?

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